3.9 b derivatives of logarithms

$$\boxed{\frac{d}{dx}\ln x = \frac{1}{x}}$$

$$\frac{d}{dx}\ln(x^3+x) = (3x^2+1)\cdot\frac{1}{x^3+x}$$

product

$$\frac{d}{dx}\ln(u) = \frac{du}{dx}\ \frac{1}{u}$$

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$$\boxed{\frac{d}{dx}\ln u = \frac{du}{dx}\cdot\frac{1}{u}}$$

$y = \log x$ (means $\log_{10} x$)

$\frac{dy}{dx} = ?$ $\frac{1}{x\ln 10}$

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change of base $\log_a x = \frac{\log_b x}{\log_b a}$

$$\log_{10} x = \frac{\log_e x}{\log_e 10}$$

$$\log x = \frac{\ln x}{\ln 10}$$

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$$\boxed{\frac{d}{dx}\log_a u = \frac{du}{dx}\cdot\frac{1}{u\ln a}}$$

properties of log

$\log(ab) = \log a + \log b$ same

$\log\left(\frac{a}{b}\right) = \log a - \log b$ for ln

$\log a^x = x\log a$

$\ln e = 1$ $\ln e^x = x$

$e^{\ln x} = x$

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$$\frac{d}{dx}\log(\sin x) = \cos x\ \frac{1}{\sin x\cdot\ln 10} = \frac{\cot x}{\ln 10}$$

$$\frac{d}{dx}\frac{e^{2x}}{\log_5 x^2} = \frac{\log_5 x^2\cdot 2e^{2x} - e^{2x}\cdot 2x\cdot\frac{1}{x^2\ln 5}}{(\log_5 x^2)}$$

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logarithmic differentation

1. take ln of both sides
2. use properties of ln to simplify
3. implicit differentiation
4. solve for $\frac{dy}{dx}$

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$$y = x^x \qquad \text{find } \frac{dy}{dx}$$

1. $\ln y = \ln x^x$
2. $\ln y = x \ln x$
3. $\frac{dy}{dx} \cdot \frac{1}{y} = x \cdot \frac{1}{x} + \ln x \cdot 1$ take der wrt x of both sides
4. $\frac{dy}{dx} = y(1 + \ln x)$
   $= x^x(1 + \ln x)$

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#45 $\ln y = \sqrt[5]{\frac{(x-3)^4(x^2+1)}{(2x+5)^3}} = \ln\left(\frac{(x-3)^4(x^2+1)}{(2x+5)^3}\right)^{1/5}$

$$\ln y = \frac{1}{5}\ln\frac{(x-3)^4(x^2+1)}{(2x+5)^3}$$

$$\ln y = \frac{1}{5}\left[\ln (x-3)^4(x^2+1) - \ln(2x+5)^3\right]$$

$$\ln y = \frac{1}{5}\left[\ln(x-3)^4 + \ln(x^2+1) - \ln(2x+5)^3\right]$$

$$\ln y = \frac{1}{5}\left[4\ln(x-3) + \ln(x^2+1) - 3\ln(2x+5)\right]$$

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